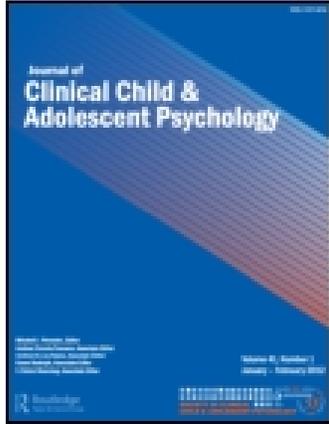


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Journal of Clinical Child & Adolescent Psychology

Publication details, including instructions for authors and subscription information:
<http://www.tandfonline.com/loi/hcap20>

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Published online: 20 Feb 2014.



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To cite this article: Joseph C. Franklin, Jeremy P. Jamieson, Catherine R. Glenn & Matthew K. Nock (2015) How Developmental Psychopathology Theory and Research Can Inform the Research Domain Criteria (RDoC) Project, *Journal of Clinical Child & Adolescent Psychology*, 44:2, 280-290, DOI: [10.1080/15374416.2013.873981](https://doi.org/10.1080/15374416.2013.873981)

To link to this article: <http://dx.doi.org/10.1080/15374416.2013.873981>

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How Developmental Psychopathology Theory and Research Can Inform the Research Domain Criteria (RDoC) Project

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The recently proposed Research Domain Criteria (RDoC) project has the potential to stimulate new research and overcome many of the limitations of the *Diagnostic and Statistical Manual of Mental Disorders* taxonomy. In the present article we focus, in three main sections, on how theory and research from developmental psychopathology can inform RDoC. First, we discuss the ontology of mental illness and the potential advantages of the RDoC approach to understanding the nature of mental illness. Second, we note potential issues to consider when implementing the RDoC framework, including (a) integrating developmental processes, (b) classifying mental illness within a dimensional approach, and (c) avoiding problems associated with biological reductionism. Third, we describe how a developmental psychopathology perspective may inform each of these potential issues within RDoC. Finally, we highlight the study of emotion and the centrality of affective processes within the RDoC framework. Specifically, we describe how constructionist models of emotion are consistent with developmental psychopathology and how this perspective on emotion can help to guide RDoC research.

The primary purpose of this article is to discuss how developmental psychopathology research and theory can inform the Research Domain Criteria (RDoC) project. We first provide a foundation for this discussion by examining psychopathology through the lens of ontology, highlighting the limitations of the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* taxonomy, and noting how the RDoC approach overcomes some of these limitations. We then describe important issues to consider when implementing the RDoC framework and discuss how a developmental psychopathology approach can inform these issues. Finally, we conclude by discussing how constructionist models of

emotion may advance RDoC and developmental psychopathology research.

ONTOLOGY, NATURAL KINDS, AND PSYCHOPATHOLOGY

Since 1996, the Chicago White Sox baseball club has been inviting fans to bring their dogs to the ballpark during their “Dog Days of Summer” promotional event. As the fans and their dogs sit at the ballpark, they may see baseballs fly over the outfield fence. Although the fans may cheer in response to these events, the behavior of the dogs is unaffected. What is responsible for these different reactions?

According to the philosopher John Searle (1995), the baseball flying over the fence is a “brute physical fact”

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and is ontologically objective because it exists in the absence of a human perceiver. Thus, both the fan and the dog can observe this fact. In contrast, the meaning of a baseball flying over the fence (e.g., a home run) is an “institutional fact” and is ontologically subjective because it requires a human perceiver. Correspondingly, only the fan observes and reacts to this fact. Although institutional facts are grounded in brute physical facts, they cannot be reduced to brute physical facts. For instance, a home run involves a ball flying over a fence, but there is nothing intrinsic about this event that makes it a home run. This is because institutional facts comprise an additional dimension based on language and collective intentionality (i.e., mental representation of phenomena outside of one’s own mind), which ascribe status and function to physical phenomena. As collective intentionality shifts across social contexts, the nature of the institutional facts also shifts. For example, the same brute physical fact of a baseball flying over a fence may be simultaneously cheered by fans from New York and lamented by fans from Boston.

Much like home runs, psychological constructs are ontologically subjective. This means that, unlike chemical elements or physical particles, psychological constructs are not “natural kinds”—ontologically objective entities or classes of entities that occur in the absence of a human perceiver and have natural boundaries. Even seemingly simple psychological constructs such as emotions do not qualify as natural kinds (see Barrett, 2012; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012). Although emotions such as fear and happiness exist, they do not exist in the same way that oxygen and carbon exist; rather, they exist in a manner similar to homeruns and foul balls. That is, emotions—even one’s own emotions—require a human perceiver to exist, are not intrinsic properties of brute physical facts (e.g., brain activity), and shift substantially across social contexts (see Barrett, 2012).

This classification also applies to more complex psychological constructs such as psychopathologies. Because these constructs do not exist in the objective sense, it is difficult to form a valid taxonomy of psychopathology. Such taxonomies can be highly reliable without being valid (i.e., without accurately reflecting the true nature of psychopathology). This is because ontologically subjective phenomena can still be evaluated with epistemic objectivity (Searle, 1995). For example, strikeout statistics can be compared across baseball pitchers with a high degree of epistemic objectivity, but this does not mean that strikeouts are ontologically objective entities that naturally exist independent of human perception and social context. Indeed, the “strikeout” construct has shifted across time: Before 1889 a strikeout required four strikes (now three), and foul balls were not counted as strikes (now they

can be; Richter, 1914). The DSM taxonomy of psychopathology has become increasingly reliable (at least in terms of major mental disorders assessed with structured clinical interviews), but it has well-documented weaknesses including high comorbidity among constructs, confusing boundaries between constructs, high levels of heterogeneity within constructs, and common use of “not otherwise specified” diagnoses (Widiger & Samuel, 2005). Despite its reliability, these weaknesses suggest that the DSM taxonomy does not accurately reflect the nature of psychopathology.

The difficulties in classifying mental illness are particularly striking when contrasted with advances in the nosology and treatment of physical illness. The ontological objectivity of the body facilitates the scientific study of physical diseases, generating consistent progress in the understanding and treatment of many illnesses. This state of affairs has inspired a sea change at the National Institute of Mental Health (NIMH), with the recent announcement that the “NIMH will be re-orienting its research away from DSM categories” and toward a new dimensional system (Insel, 2013).

THE RDOC PROJECT

Inspired by advances in the study of physical illness, the NIMH recently introduced the RDoC project to establish a more ontologically objective taxonomy of mental illness by recasting psychopathology as pathophysiology (Insel, 2013; Insel et al., 2010; S. E. Morris & Cuthbert, 2012; Sanislow et al., 2010). With this more ontologically objective model, NIMH is optimistic about an improved understanding of mental illness: “Our expectation, based on experience in cancer, heart disease, and infectious diseases, is that identifying syndromes based on pathophysiology will eventually be able to improve outcomes” (Insel et al., 2010, p. 749).

The overall goal of RDoC is to develop a new classification of psychopathology based on dimensions of neurobiological and behavioral measures that will ultimately advance the understanding and treatment of mental disorders (see Sanislow et al., 2010). Although the stated focus of RDoC includes both neurobiological and behavioral measures, in practice, RDoC tends to place a more central emphasis on neurobiology. Indeed, the three major assumptions of RDoC all center on neural circuits: (a) mental illnesses are disorders of brain circuits; (b) neuroscientific methods can identify dysfunctions within brain circuits; and (c) knowledge about disordered circuits eventually will direct the classification, assessment, intervention, and management of mental illnesses (see Insel et al., 2010; S. E. Morris & Cuthbert, 2012; Sanislow et al., 2010). The RDoC

project aims to accomplish this latter goal by stimulating research that identifies dysfunction across several domains (e.g., positive valence, negative valence, cognition, arousal/regulation, and social processes) and levels of analysis (e.g., genes, molecules, cells, circuits, physiology, behavior, and self-report). This project is in its initial stages and is viewed as a decade-long (at least) endeavor to build a database of genetic and neuroscientific data to revolutionize the understanding and treatment of psychopathology (see S. E. Morris & Cuthbert, 2012).

The RDoC approach has important advantages over the traditional *DSM* approach. First, RDoC is agnostic about current *DSM* constructs. This strategy frees researchers to make transdiagnostic discoveries that have the potential to advance knowledge about the boundaries of mental illness. Second, RDoC takes a dimensional approach to mental illness. Although this approach is not completely free from a “natural kinds” view of psychopathology because the dimensions themselves might be conceptualized as natural kinds, it is a major advance over the *DSM* position that there are hundreds of objective, discrete mental illnesses with firm boundaries. Third, compared to the top-down, rationally derived approach of the *DSM*, RDoC takes a bottom-up, empirically driven approach to understanding psychopathology. Studies that have attempted to develop empirically derived taxonomies based on shared phenomenological features of mental disorders have produced results that conflict with traditional *DSM* categories (e.g., Watson, 2005). One would expect that an empirically derived taxonomy based on a broader range of (comparatively objective) domains included in the RDoC would produce an even more valid taxonomy. We revisit these major changes in the following section as we examine parallels between the RDoC framework and the developmental psychopathology perspective.

DEVELOPMENTAL PSYCHOPATHOLOGY AND RDOC

In the context of the aforementioned advantages, there also are important issues to consider when conducting research within the RDoC framework. Developmental psychopathology researchers have long noted the same *DSM* limitations that inspired RDoC (see, e.g., Beauchaine, Klein, Erickson, & Norris, 2013; Richters & Cicchetti, 1993). Correspondingly, these researchers have encountered and addressed many of the issues that now face RDoC. Here, we describe these issues, note how they could limit RDoC, and discuss how developmental psychopathology research and theory helps address these issues.

RDoC and Development

The role of development. Although development is not explicitly included within the RDoC matrix, a central RDoC goal is to understand the neurodevelopmental origins of mental illness (S. E. Morris & Cuthbert, 2012). However, given how recently the RDoC model was proposed, there is little information on how the new framework will promote this goal. As a result, research using the RDoC approach may be less likely to effectively integrate essential developmental processes. We propose that developmental psychopathology theory and research can inform this aspect of RDoC by facilitating the integration of crucial developmental processes.

Developmental psychopathology focuses on how vulnerabilities (both biological and psychological) interact with environmental factors across the lifespan (Cicchetti, 1993; Sroufe & Rutter, 1984). Consistent with the general RDoC framework, this perspective centers on pathophysiological processes across several units of analysis rather than descriptions of diagnostic categories or syndromes (Cicchetti, 1993; Rutter & Sroufe, 2000). Inconsistent with the RDoC model (e.g., S. E. Morris & Cuthbert, 2012), however, developmental psychopathology does not place its central emphasis on neural circuits or equate psychopathology to pathophysiology. Instead, the developmental perspective gives equal weight to different units of analysis and focuses on the dynamic interplay of these units across development (Cicchetti, 2008; Cicchetti & Blender, 2004).

For example, developmental research has revealed important *interactions* between genetic polymorphisms and adverse life events in the pathogenesis of psychopathology among youth (e.g., Dodge, 2009; Kim-Cohen et al., 2006). Going beyond general gene-environment interactions (e.g., Caspi & Moffitt, 2006), developmental psychopathology emphasizes moderators of these pathways, especially changes *across the lifespan*. For instance, heritability estimates for many psychiatric symptom domains (e.g., anxiety and depressive symptoms, and externalizing behaviors) increase from adolescence through young adulthood (Bergen, Gardner, & Kendler, 2007), indicating moderation by developmental stage. In addition, research has demonstrated that gene-environment interactions are moderated by large-scale environmental factors, such as socioeconomic status, with environmental factors predominating among those from disadvantaged environments (Turkheimer, Haley, Waldron, D’Onofrio, & Gottesman, 2003).

Such studies demonstrate the value of considering multiple units of analysis (vs. centering psychopathology on neural circuits) and illustrate that transactions among variables are complex and that risk factors do

not confer uniform risk for all people or in the same way for an individual across the lifespan (Cicchetti, 1993; Rutter & Sroufe, 2000). This suggests that a given RDoC profile (i.e., cluster of features across several units of analysis) may be associated with different psychopathological symptoms across people and time. For instance, Beauchaine and colleagues' biosocial developmental model of conduct problems suggests that inherited genetic and psychological vulnerabilities can lead to a variety of behavioral outcomes depending on the transactional nature of the social environment over *the course of childhood and adolescence* (Beauchaine, Gatzke-Kopp, & Mead, 2007).

Recommendations for RDoC. First, RDoC may benefit from more explicit integration of transactional developmental processes into its framework. For instance, it could be useful to incorporate concepts from developmental psychopathology, such as equifinality and multifinality (see Cicchetti & Rogosch, 1996), that consider how dynamic interactions among inherited vulnerabilities are moderated by powerful factors across the lifespan to impact the expression of psychopathology. Second, it is critical that RDoC consider a broader view of development rather than centering on neurodevelopment. Although neurodevelopment is important, psychopathological processes are powerfully affected by developmental stage and environmental factors across many units of analysis.

RDoC and Classification

Classification within a dimensional framework. The RDoC is agnostic about the current *DSM* categories and instead takes a dimensional perspective on the nature of psychopathology. Although this approach ultimately seeks to develop a novel classification system (Sanislow et al., 2010), RDoC does not currently indicate how mental illnesses will be classified using this framework. It is difficult to reconcile a dimensional approach with a classification system (which implies categories and discrete entities). For example, from a dimensional perspective, at what point will a given individual qualify for a mental illness? And how will the various illnesses be distinguished from one another? As previously described, psychopathologies are not natural kinds, so nature will not objectively sort out these boundaries. Notably, this does not preclude the formation of firm boundaries between mental illnesses—there are distinct demarcations for other ontologically subjective phenomena such as home runs and foul balls—but strategies for constructing these boundaries must be formally articulated.

Given its focus on examining psychopathology in a dimensional and contextual manner, developmental

psychopathology has developed classification strategies that may inform RDoC. First, the developmental psychopathology perspective has, for decades, used a dimensional framework to assess and monitor clinical symptoms (e.g., the Child Behavior Checklist; Achenbach, 1991). Dimensional examples from developmental psychopathology, such as the Child Behavior Checklist, may help inform the creation of clinically significant thresholds, cutoff scores, and profiles across dimensional constructs within the RDoC framework. Second, in terms of larger contextual considerations, developmental psychopathology defines atypical processes against a backdrop of normative processes that vary across development (Beauchaine, 2001; Cicchetti, 1993; Drabick & Kendall, 2010; Sroufe & Rutter, 1984). For instance, adolescence is a developmental period marked by elevated reward seeking and risk taking (e.g., Steinberg et al., 2008) and increased emotional reactivity (e.g., Larson, Moneta, Richards, & Wilson, 2002), compared to both childhood and adulthood. Accordingly, some rule-breaking behavior in a 17-year-old may be viewed as developmentally typical, whereas the presence of these same behaviors in a 6-year-old child could be considered clinically significant and symptomatic of a psychiatric disorder (e.g., truancy and staying out later than curfew *before age 13* is symptomatic of conduct disorder; Drabick & Kendall, 2010).

In addition to providing context for general definitions of psychopathology, the developmental psychopathology strategy can also inform how to draw boundaries between normative and atypical processes (Rutter & Sroufe, 2000). Of importance, research indicates that these boundaries may vary widely depending on the nature of the underlying psychopathology. If we return to our initial baseball example, boundaries for some phenomena may be inherently blurry, as with an umpire's determination of balls and strikes in baseball; for other phenomena, boundaries may be clear, as with the determination of a fair or foul ball; and still other phenomena may have mixed boundaries.

With regard to psychopathology, certain psychiatric symptoms, such as oppositional defiant behaviors and depressive symptoms, may demonstrate relative continuity between normative and atypical groups and therefore may be appropriately evaluated on the same continuum (Beauchaine, 2003; Drabick, 2009; Maser et al., 2009). However, other clinical features, such as schizophrenia spectrum symptoms and specific conduct disorder behaviors (e.g., forced sex and fire setting), are viewed as discontinuous with normative processes; thus, these psychopathology categories may have distinct etiologies and be more suitably classified as discrete categories (Beauchaine, 2003; Drabick, 2009). Still other psychiatric features entail both continuous and

discontinuous aspects (Beauchaine, 2003; Rutter & Sroufe, 2000). For example, although depression exhibits some continuity with normative processes, psychotic symptoms that occur within severe mood states may be discrete and discontinuous clinical features (Rutter & Sroufe, 2000). Moreover, even subthreshold depression has been associated with clinical impairment, suggesting that the presence of any depressive symptom may be clinically significant and discontinuous with normality (see Maser et al., 2009).

We have focused on how developmental psychopathology can inform RDoC; however, classification within a dimensional system is an area where the RDoC framework can inform developmental psychopathology. RDoC research identifying continuities and discontinuities along a range of transdiagnostic domains could help address some of the problems resulting from the current categorical classification system. For instance, this research may help explain high diagnostic comorbidity in children and adolescents by identifying shared causal mechanisms (e.g., Beauchaine et al., 2007). Similarly, research using transdiagnostic dimensions may be able to more effectively track the heterotypic continuity of psychiatric symptoms observed across childhood and adolescence because it does not rely on discrete categorical boundaries (Beauchaine, 2003; Drabick, 2009). Moreover, a transdiagnostic dimensional approach, which retains important information about symptom levels regardless of diagnostic thresholds, may be particularly useful for early detection, prediction of diagnostic course, and prevention of future psychopathology.

Recommendations for RDoC. RDoC may benefit from establishing guiding classification principles for the new psychopathology taxonomy. Although we agree that an agnostic view of mental illness constructs will facilitate initial research, eventually this research must coalesce into a new taxonomy. As previously noted, because psychopathologies are not natural kinds, nature will not sort out these classification boundaries; these boundaries will be set by researchers. Accordingly, it may be helpful if the developmental psychopathology principles and research noted earlier are integrated into RDoC research.

RDoC and Biological Reduction

The potential for reductionism. Sanislow et al. (2010) acknowledged that the RDoC may seem to lend itself to biological reductionism, noting that “with a strong focus on biological processes, and emphasis on neural circuits at the outset, the RDoC effort could be construed as reductionist” (p. 633). In fact, potential

problems associated with reductionism can be traced back to a fundamental assumption underlying the RDoC—that mental disorders are brain disorders (Insel, 2013; Insel et al., 2010; S. E. Morris & Cuthbert, 2012). This assumption may betray one of the major advantages of RDoC: Its inclusion of a wide range of units of analysis. RDoC accordingly has the potential to stimulate research across multiple levels and to suggest connections among various levels of analysis. It is critical that RDoC research maintain this strength and avoid biological reductionism—tempting as it might be.

The major argument for avoiding biological reductionism is that subjective mental phenomena are not objective physical phenomena, and that if one attempts this translation, important information will be lost (see Miller, 2010, for an extended discussion). To illustrate, Kosslyn and Koenig (1992) suggested that this translation would be akin to “replacing a description of architecture with a description of building materials. Although the nature of the materials restricts the kind of building that can be built, it does not characterize their function or design.” (p. 4). Likewise, Barrett (2012) noted that it is critical to recognize that psychological constructs “can be causally reduced, but not ontologically reduced, to the brain states that create them” (p. 424). Just as a home run would not exist without a baseball, psychopathology would not exist without the brain; yet, home runs cannot be reduced to baseball activity and psychopathology cannot be reduced to brain activity.

Although the RDoC model suggests data from multiple levels of analysis are useful for understanding psychopathology, it does not specify *how* multiple levels of analysis can, or should, be combined to increase knowledge. It is important to note, however, that the RDoC framework has been proposed as a long-term project and the developers acknowledge that it may take several years to determine how to combine information across several levels (Sanislow et al., 2010).

The developmental psychopathology approach may provide an effective model for how to conduct research across multiple domains and units of analysis. As discussed previously, this perspective values all levels of analysis (rather than centering on neural circuits) and emphasizes the importance of interactions across levels (Beauchaine, 2001; Thomas, Aldao, & De Los Reyes, 2012). Moreover, from a developmental psychopathology perspective, any single unit of analysis in isolation (e.g., only considering neural circuits) is insufficient for elucidating the pathogenesis of psychopathology (Cicchetti, 2008; Cicchetti & Blender, 2004). There is not a one-to-one association between any measure and psychological construct regardless of the level of analysis (Fox, Schmidt, Henderson, & Marshall, 2007;

Thomas et al., 2012). In addition, there is limited convergence across different measurement methods (De Los Reyes et al., 2012; Quas, Hong, Alkon, & Boyce, 2000), suggesting that each unit of analysis may provide unique information to inform the overall clinical picture (De Los Reyes, 2011; Fox et al., 2007; Thomas et al., 2012). Therefore, a multi-method and multilevel developmental framework is essential for understanding these dynamic causal processes (Cicchetti & Blender, 2004).

Indeed, there is a long tradition of evidence-based assessment in child and developmental psychology that incorporates multiple methods (most frequently self-reports and observational behavioral methods; Achenbach, McConaughy, & Howell, 1987; Hunsley & Mash, 2007; A. S. Morris, Robinson, & Eisenberg, 2006). Taken together with the existing and growing research in behavior genetics (e.g., Bergen et al., 2007; Kim-Cohen et al., 2006), developmental neuroscience (e.g., Casey, Tottenham, Liston, & Durston, 2005; Dahl, Silk, & Siegle, 2012; Fox & Davidson, 1986; Pine, Guyer, & Leibenluft, 2008) and developmental psycho-physiology (e.g., Beauchaine, 2001; Beauchaine et al., 2007; Fowles, Kochanska, & Murray, 2000), developmental psychopathology has a solid research foundation across multiple levels of analysis ideal for the framework proposed by the RDoC model.

For example, Beauchaine and colleagues have illustrated how multiple levels of analysis (cf. Cicchetti, 2008) can be utilized to inform the etiology and pathogenesis of developmental psychopathology, particularly related to impulsiveness in children and adolescents. These efforts led to the development of a biopsychosocial model suggesting that inherited genetic (dopamine related) and psychological (impulsiveness) vulnerabilities interact with environmental factors (high risk or protective) to result in a range of behavioral outcomes (conduct disorder and ADHD, or ADHD only) across the lifespan (Beauchaine & Gatzke-Kopp, 2012; Beauchaine et al., 2007). Within this model, children inherit vulnerabilities for meso-limbic dopamine dysfunction (e.g., genetic level; also note that dysfunction can arise through other routes), then the environment impacts the child's emotion regulation skills (e.g., respiratory sinus arrhythmia as one partial indicator; physiological level), and finally vulnerability-environment interactions result in behavioral outcomes (e.g., conduct problems; behavioral level). This model demonstrates how assessment across multiple levels of analysis (from genes to self-report) is essential for accurately understanding the trajectory of psychopathology. Moreover, a similar biopsychosocial approach could help inform mechanisms underlying high rates of diagnostic comorbidity (given shared genetic and psychological vulnerabilities),

multifinality (different outcomes resulting from varied gene-environment interactions), and heterotypic continuity (genetic and environmental factors confer differential risk over time; Beauchaine et al., 2007).

Researchers in developmental psychopathology also have suggested how a multilevel, multimethod approach can be applied to clinical practice (Bakker, Tijssen, Koelman, & Boer 2011; Thomas et al., 2012). For instance, Thomas et al. (2012) described how physiological measures (e.g., heart rate monitoring), behavioral observations (e.g., clinician ratings), and self-report ratings (e.g., subjective units of distress) can be combined to gauge anxiety treatment response by monitoring patients' habituation during in vivo and imaginal exposures. Given the low rates of concordance across multiple measurement methods (De Los Reyes et al., 2012; Quas et al., 2000), the discrepancy between these measures of affective arousal could also be informative for treatment. For example, objective measures, such as heart rate, may indicate reduced physiological reactivity despite maintained elevations in subjective distress assessed with self-report measures. Taken together, each level of analysis may provide unique information and combining across these levels may help improve the richness of the clinical picture.

Recommendations for RDoC. First, it will be important for RDoC to broaden its emphasis to include multiple potential causes of mental disorders. In practical terms, this would mean no longer defining mental disorders as brain disorders (see Miller, 2010). In broader theoretical terms, this requires recognizing that biological phenomena are limited in their ability to explain psychological phenomena. On the surface, recasting psychopathology as pathophysiology and approaching mental disorders as brain disorders (e.g., Insel et al., 2010) would seem to be a highly effective strategy. As previously outlined, however, this translation loses information vital to understanding psycho-pathology (Cicchetti, 2008; Cicchetti & Blender, 2004). Second, the RDoC model may benefit from considering examples from developmental psychopathology (e.g., Beauchaine, 2001; Beauchaine & Gatzke-Kopp, 2012; Thomas et al., 2012) when combining information across units of analysis. Understanding the interplay between multiple levels of analysis will more rapidly advance research and treatment efforts.

To this point, we have discussed how developmental psychopathology principles can be used to inform the RDoC framework broadly. In the next section, we extend the ideas presented above to discuss the more specific case of how a research on emotion can inform RDoC research in emotion-related domains.

RDOC, DEVELOPMENTAL PSYCHOPATHOLOGY PRINCIPLES, AND EMOTION

The RDoC framework is replete with domains and constructs directly related to affective processes, including active threat (“fear”), potential threat (“anxiety”), sustained threat, frustrative nonreward, approach motivation, reward responsiveness, attention/perception, cognitive control, theory of mind, social dominance, facial expression identification, attachment, and arousal and regulation. Researchers across disparate areas of psychology have been employing multimethod, multilevel techniques to study emotion for years. This work has coalesced into two major emotion models—the natural kinds and constructionist models—that have fundamentally different assumptions and would send emotion-based RDoC research into two fundamentally different directions. In this section, we begin by briefly describing these models and their relevance to developmental psychopathology principles. Then we discuss how the constructionist approach would be the most beneficial for RDoC research. Specifically, we describe how research on emotion constructionism promotes multidisciplinary methods, avoids biological reduction-ism, and informs the organization and development of constructs within RDoC.

Emotion Models

Emotions as natural kinds. Many researchers have posited that discrete emotions (e.g., anger, disgust, fear, happiness, sadness, etc.) are natural kinds. Although some of these models hold that developmental period and social context influence the expression of emotions (e.g., Izard, 2007), all of these models possess the core assumption that there are dedicated modules in the mammalian nervous system that generate specific emotions (e.g., fear) and emotion-related behaviors (e.g., freezing; see Ekman, 1992; Izard, 2007; Panksepp, 2000). Based on these natural kinds models, researchers have sought to isolate correlates of basic emotion modules. For example, researchers have proposed specific facial expressions (e.g., Ekman, Freinsen, & Ancoli, 1980) and neural correlates (e.g., Vytal & Hamann, 2010) for each discrete emotion. However, this perspective is largely inconsistent with developmental psychopathology and affective neuroscience (e.g., Lindquist et al., 2012). Whereas developmental psychopathology emphasizes how emotions may vary across developmental period, social context, and unit of analysis, natural kinds models hold that discrete emotions are irreducible entities that remain largely static across development, context, unit of analysis, and even species. As previously noted, emotion-based RDoC research conducted within

natural kinds models may lend itself to some of the potential issues in the previous section (e.g., Vaidyanathan, Nelson, & Patrick, 2012).

Emotion construction. A growing corpus of research has accumulated that fails to support natural kind models of emotion (see Barrett, 2006, 2012; Barrett et al., 2007; Lindquist et al., 2012; Wilson-Mendenhall, Barrett, Simmons, & Barsalous, 2011). For example, identical biological signals can produce different emotional expressions depending solely on perception (e.g., Jamieson, Mendes, & Nock, 2013). Likewise, meta-analytic evidence indicates that several brain areas are sensitive to various emotions, but no brain areas are linked to specific discrete emotions (Lindquist et al., 2012). Overwhelming empirical evidence supports the view that emotions are constructed from fundamental psychological ingredients such as valence, arousal, motivation, and social context (see Barrett, 2011, 2012; Lindquist et al., 2012). For example, Lindquist and Barrett (2008) exposed participants to a fear, anger, or neutral prime; induced an unpleasant, high-arousal state; and then measured risk aversion (an indirect indicator of fear). Consistent with constructionist models, only participants primed with fear displayed heightened risk aversion.

This perspective on emotion is highly consistent with developmental psychopathology principles. As in developmental psychopathology theory, these models emphasize the contributions of multiple levels of analysis to emotion and stress the importance of context for emotional experience (Barrett, Mesquita, & Gendron, 2011). Accordingly, we propose that a constructionist approach will facilitate emotion-focused RDoC research and help avoid the potential issues noted in the preceding section. We describe these advantages in the next section.

Advantages of a Constructionist Approach for RDoC

The RDoC framework does not explicitly subscribe to either of the aforementioned perspectives on emotion (construction vs. natural kinds). Some aspects of RDoC, such as the “fear” and “anxiety” domains, could be construed as being consistent with a natural kinds approach. Many other aspects of RDoC, however, lend themselves to a constructionist approach. For example, consistent with constructionist models’ focus on fundamental psychological ingredients, RDoC includes multiple units of analysis and domains such as arousal, approach motivation, and attention. Just as these ingredients may be combined to construct emotions (see Barrett, 2011), these ingredients could be combined to

construct psychopathological processes. We propose that RDoC would benefit from more explicitly integrating a constructionist approach to emotion. Specifically, complementing the developmental psychopathology approach previously noted, a constructionist approach to emotion would help RDoC researchers avoid limitations related to reductionism, classification, and development.

Emotion construction and biological reductionism. Natural kinds models of emotion lend themselves to reductionism because attempts are made in these models to link specific emotions to dedicated and specific neural circuitry or modules (e.g., Ekman et al., 1980; Ohman & Mineka, 2001). As previously noted, however, meta-analytic and experimental evidence is inconsistent with this view (Lindquist et al., 2012). Thus, attempts to study specific emotions at the neural level (or below) result in nonspecific findings with limited utility for understanding psychopathology. A constructionist approach—similar to developmental psychopathology—integrates information from multiple units of analysis to construct transdiagnostic phenomena such as acute threat or “fear.” Notably, biological processes, though a valuable component, are not the primary focus.

To illustrate, consider the specific RDoC domain of acute threat or “fear.” This RDoC construct likely plays a central role in several mental illnesses, but it is not clear from RDoC which approach should be taken when studying fear. This question has significant implications for the direction of RDoC research as well as the classification, assessment, and treatment of psychopathology. A natural kinds perspective views “fear” as a discrete emotion with a neural circuit that is automatically activated in response to certain stimuli (cf. Ohman & Mineka, 2001). Based on this perspective, it is crucial to identify the fear circuit in the brain. Consistent with this notion, RDoC regards various brain areas (e.g., amygdala, insula) and psychophysiological responses (e.g., startle eyeblink reactivity in aversive contexts) as potential measures of fear. However, meta-analytic evidence indicates that brain regions, such as the amygdala and anterior cingulate cortex, are sensitive to myriad other emotions and psychological processes in addition to fear (Lindquist et al., 2012). Similarly, although many researchers regard startle eye-blink reactivity as indicative of fear (e.g., Vaidyanathan et al., 2012), several studies failed to find that heightened fear correlated with elevated startle response (e.g., Hawk & Kowmas, 2003), and other studies have found that diminished startle is associated with approach-related emotions rather than fearlessness (e.g., Amodio & Harmon-Jones, 2011; Franklin, Lee, Hanna, & Prinstein, 2013).

Contrary to RDoC’s focus on specific neural circuits, such findings indicate that there is no localized, dedicated “fear circuit” (cf. Lindquist et al., 2012). Accordingly, attempts to understand or classify psychopathology based on the assumption of such circuits will be unsuccessful. Instead, fear and related psychopathological processes may be best understood by studying the separate ingredients of the emotional response (see Barrett, 2011). As highlighted in our earlier example, high-arousal, negative-valenced, avoidance-motivated emotional responses are labeled as “fear” or “anxiety” in many situations (Lindquist & Barrett, 2008); however, fear can also be associated with positive valence (see Wilson-Mendenhall, Barrett, & Barsalou, 2013). To understand fear, researchers should measure arousal, valence, and motivation using measures across various levels of analysis and view emotions as situated conceptualizations rather than static modules (see Wilson-Mendhall et al., 2011). Reducing or centering RDoC domains on neural circuitry will miss information essential to understanding any psychopathology associated with dysfunctions in emotion.

Recommendations for RDoC. To facilitate the integration of a constructionist approach and to avoid reductionism, RDoC may benefit from adopting a strategy of triangulating psychopathological processes from multiple constructs and units of analysis. By not seeking to distill emotions to neural processes, constructionist models have stimulated research on the triangulation of affective states through integrating findings across multiple levels of analysis.

To illustrate a triangulation approach, imagine a researcher who is interested in affective processes that underlie internalizing and externalizing psychopathology in children. However, the researcher works with children who are unable, or unwilling, to accurately report their affective experiences (cognitive, behavioral, and physiological). To overcome this roadblock, the researcher decides to assess the children’s affective responses during a demanding task using a multimethod, multilevel approach. For instance, the researcher might affix a sensor to monitor the variation of electrodermal activity because of the well-established relationship between skin conductance and arousal. Arousal alone, however, is not indicative of affective state but helps eliminate the possibility of flat-affect or disengagement. The research also includes a rating scale of mood state valence (i.e., positive, neutral, and negative). From these measures, the researcher aims to identify if children are experiencing a high-arousal, negative valence affective state. But the question remains: Is the child anxious or angry? This question may be answered by the child’s approach-avoidance motivational orientation (Elliot,

2006): anxiety typically is associated with avoidance displays, whereas anger typically is related to approach behaviors (e.g., Jamieson, Koslov, Nock, & Mendes, 2013). If the observational data indicate avoidance motivation, this suggests a high-arousal, negative-valenced, avoidance-motivated affective state such as anxiety or fear. In this case, the researcher used psycho-physiological (electrodermal activity), self-report (mood scale), and behavioral (observations) measures to triangulate the child's affective experience.

Emotion construction, classification, and context. A constructionist approach may also aid in the classification of mental illness within RDoC. As previously noted, substantial evidence indicates that emotions are situated conceptualizations (e.g., Lindquist & Barrett, 2008; Wilson-Mendenhall et al., 2011). Correspondingly, any boundary between normative and atypical emotion must consider social context. For example, elevated heart rate, sweaty palms, and a rush of blood to the brain are perfectly normal responses for a baseball hitter staring down a pitcher, but those same responses might signal the onset of a panic attack when they occur in situations in which arousal is not functional. Thus, the same affective responses can be typical or atypical depending on the social context (cf., Jamieson, Mendes, et al., 2013).

Contrary to RDoC assumptions (see Insel et al., 2010; S. E. Morris & Cuthbert, 2012; Sanislow et al., 2010) psychopathological boundaries related to emotion cannot be drawn purely with biology. Instead, consistent with the developmental psychopathology approach, these boundaries will include biological information but also must consider relationships to normative processes, social context, and developmental period. For instance, a 5-year-old exhibiting anxiety or fear when sleeping in a dark room without a night-light is typical, but the same response in a 30-year-old is atypical and might suggest underlying psychopathology.

Just as development and context must be taken into account, boundaries between disorders or psychopathologies cannot be accurately defined without the proper domains and constructs. Affective science strongly suggests valence, arousal, and motivation are all important determinants of emotion. Whereas the RDoC model includes negative valence, positive valence, and arousal domains, motivation is conspicuously absent. Instead approach-motivation is listed in the "positive valence system" domain. However, as previously discussed, research indicates that approach motivation is not necessarily positive. This is best exemplified by anger (Carver & Harmon-Jones, 2009). In fact, the developmental psychopathology literature indicates that anger, specifically low frustration tolerance and quickness to

anger, underlies externalizing problems in children (Bates, 2000; Rothbart & Bates, 1998). An RDoC-inspired researcher studying motivational processes in child psychopathology would have a difficult time reconciling the anger observed in children with externalizing problems as a "positive valence" construct.

Recommendations for RDoC. First, emotion-related RDoC research may benefit from explicitly considering normative processes, social context, and developmental period. Discrete emotions are situated conceptualizations (e.g., Barrett, 2012; Wilson-Mendenhall et al., 2011) that require factors like social context to exist. It is accordingly essential to consider such factors when studying and classifying potentially pathological emotional processes. Second, to improve the potential for RDoC to meaningfully inform classification, diagnosis, and treatment of mental illness, the model should consider integrating a motivation domain and combining the positive and negative valence domains into a dimensional "valence" domain.

CONCLUSION

Mental illnesses are ontologically subjective phenomena that are difficult to classify with a high degree of validity because they may change across time and context and do not have natural boundaries. The *DSM* taxonomy has well-documented limitations, and the RDoC approach holds promise for substantially improving the understanding and treatment of psychopathology. In this article, we described some challenges ahead for the RDoC project and offered suggestions regarding how developmental psychopathology research and theory may inform these issues and facilitate the actualization of the ultimate goals of RDoC. We similarly described how a constructionist perspective on emotion may hold several advantages for RDoC and developmental psychopathology. It is hoped that the present article will facilitate the integration of the RDoC, developmental psychopathology, and constructionist models of emotion.

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